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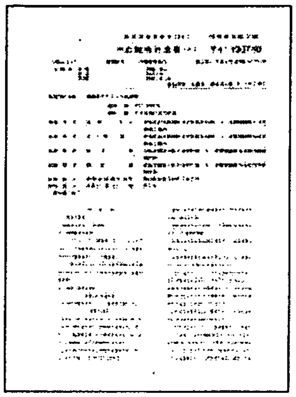

Title: FIBER-REINFORCED CEMENT COMPOSITION

Abstract:

PURPOSE: To obtain a fiber-reinforced cement composition capable of producing a formed article excellent in compression moldability, surface smoothness and workability such as nailing and sawing by incorporating sepiolite and pulp into cement.

CONSTITUTION: (A) One hundred pts.wt. of cement, (B) 1-30 or preferably 3-25 pts.wt. of sepiolite (-type is appropriate, and the fiber diameter is preferably controlled to 0.1-0.5 m and the fiber length to 5 m), (C) 1-40 or preferably 2-30 pts.wt. of pulp (virgin pulp is preferable, and the fiber length is adjusted to 0.05-5 or preferably to 0.1-3mm) and particulate and/or porous perlite having open cells, as required, are mixed to obtain a fiber-reinforced cement composition. From 0.5 to 30 pts.wt. of particulate perlite (having 1-500 m particle diameter) and 1-120 or preferably 3-100 pts.wt. of porous perlite are mixed with 100 pts.wt. of cement.

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Publication Date: 1992-07-13

Application Date: 1990-11-27

Cites: 0

Cited By: 0

Intl Class: ***[5]C04B001410***; [5]C04B001418; [5]C04B001602; [5]C04B002802; [5]C04B002802; [5]C04B001410; [5]C04B001418; [5]C04B001602

Core: C04B001402 [2006-01]; C04B001600 [2006-01]; C04B002800 [2006-01]

Adv: *C04B001410 [2006-01]*; *C04B001418 [2006-01]*; *C04B001602 [2006-01]*; *C04B002802 [2006-01]*

ECLA:

US Class:

Field of Search:

(19) Japan Patent Office (J.P.)
(12) Official report of published patent (A)
(11) Patent application publication No. H4-193748
(43) Date of publication: July 13, 1992

(51) Int.Cl.^{5}	I.D. symbol	Patent Office Control No.
C 04B14/10		2102-4G
14/18		2102-4G
16/02		2102-4G*

Request for examination: Not requested
The number of claims: 2
(7 pages in total)

(54) Title of invention: Fiber-reinforced cement composition
(21) Patent application No. (1990) H2-327779
(22) Date of application: November 27, 1990 (H2)
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Specifications

In the following sections, supplementary words, phrases or clauses are inserted by the translator enclosed by braces { } for better understanding of readers.

1. Title of invention: Fiber-reinforced cement composition

2. Scope of patent claiming (What is claimed is:)

Claim 1: A fiber-reinforced cement composition containing sepiolite of 1 to 30 weight parts and pulp of 1 to 40 weight parts to the cement of 100 weight parts.

Claim 2: A composition as described in Claim 1 containing perlite having minute particles and/or independent porous air bubble structure.

3. Detailed description of the invention

Field of utilization in the industry

The current invention relates to a fiber-reinforced cement composition.

Background technology

On walls, floors and other parts, molded materials have been used conventionally, which are {made of} cement compositions, extruded, cured and hardened.
To extrude cement compositions, it is necessary for cement compositions to have the following performance {or properties}:
(1) High fluidity and low extrusion resistance when in the condition of water-added clay (extrusion moldability)
(2) High shape-retaining property to maintain the shape of connected compositions even after extrusion
(3) High surface smoothness of molded material, with the compositions being completely dispersed
(4) Superior reinforcing effects to increase the strength of molded object after hardening

To meet the abovementioned required performance, conventionally asbestos has been used. However, it has been revealed in recent years that asbestos has carcinogenicity, and a risk has been found that inhalation of asbestos fine particles should extremely damage human health when personnel are in manufacturing and using asbestos-containing cement molded object.

With the above background, molded objects that do not use asbestos are demanded today.

To work as the molded objects above, substances that use specific pulp for reinforcing fibers (PatPub No. S63 (1988)-256555 official report) and substances in which sepiolite is mixed (PatPub No. S63 (1988)-123851 official report) have been proposed, but they involve a problem that molding becomes difficult if it is applied to the manufacture of light-weight cement molded object or if the sectional area of mold articles is too small to the extruder screw diameter.

Furthermore, a cement composition in which sepiolite and reinforcing fibers are blended as a substitute for asbestos (PatPub No. S61 (1986)-174159 and PatPub No. H1 (1989)-141855 official report) and a cement composition in which sepiolite, light-weight aggregate and reinforcing fibers are blended (PatPub No. H2 (1990)-6360 official report) have been proposed, but they all involve problems such as molding becomes difficult, the strength lowers or surface irregularity arises (bad surface smoothness of molded object) if applied to the manufacture of light-weight cement molded object in the case that the sectional area of mold articles is too small to the screw diameter of extruding machine or if the cross sectional shape of mold articles is complicated and the ratio of the length of cross section periphery to the sectional area is too large (in the case that all extruding pressures tend to increase, when molding a thin board, for example).

Problem that the invention will solve

The current invention intends to provide fiber-reinforced cement compositions that are available for manufacturing cement molded object that are low in the extruding pressure when in the process of extrusion, superior in moldability, and that are excellent in nailing, sawing and other processibility in the case of products of {good} surface smoothness, {high} bending strength and low density, without using harmful asbestos.

Means of solving problems

The current invention relates to fiber-reinforced cement compositions that contain sepiolite of 1 to 30 weight parts and pulp of 1 to 40 weight parts to the cement of 100 weight parts.

The following paragraphs describe the current invention in detail.

For cement, arbitrary items may be used including blast furnace cement, portland cement, alumina cement, silica cement, fly ash cement, and vitriolic cement, and sepiolite and pulp are mixed to the above in order to prepare a fiber-reinforced cement composition.

Sepiolite is a clay mineral of a double-stranded structure made of a magnesium silicate compound having

the theoretical chemical formula of $Mg_8Si_{12}O_{30}(OH)_4(H_2O)_4 \cdot 8H_2O$. Sepiolite has two types: □-type and □-type, where □-sepiolite has an indefinite shape of scaly {squamiform} crystal, rather than a fiber shape, but □-sepiolite has a fiber-shaped structure with hollow holes, and is used suitably.

It takes a form of fiber with the diameter being 0.01 to 1□ and the length of 1 to 100□ or so, and among others, desirable one should have a fiber diameter of 0.1 to 0.5□ and a fiber length of 5□ or longer.

Sepiolite should be mixed by the quantity of 1 to 30 weight parts to the cement of 100 weight parts, and preferably by 3 to 25 weight parts. If the mixing quantity of sepiolite is smaller than 1 weight part, sufficient effects by the sepiolite mixing cannot be attained, and if it is greater than 30 weight parts, it worsens the flow of cement composition and also aggravates moldability such that it becomes difficult to mold complicated mold articles.

Although the kinds of pulp used in the current invention are not limited in particular, virgin pulp is more desirable than used paper pulp. The length of pulp fibers should be 0.05 to 5mm, and more preferably be 0.1 to 3mm. The pulp should be mixed by the quantity of 1 to 40 weight parts to the cement of 100 weight parts, and more preferably 2 to 30 weight parts.

If the fiber length is too short, or if the loadings are too small, moldability improvement effect by the synergy with sepiolite will be lost, and further, the reinforcing effect, for which pulp is used in general, will not be available. On the contrary, if it is too long, or the loadings are too much, dispersion will be bad, and the surface smoothness of molded object will be worsened, and at extremity, the strength will be lowered.

The weight ratio of sepiolite to pulp should be 0.1 to 10, and more preferably, be 0.2 to 5. If the weight ratio is too large, the moldability will be worsened, and if it is too small, also the dispensability will be worsened in conjunction with the moldability.

With the current invention, perlite having minute particles and/or an independent porous air bubble structure may be further blended in the fiber-reinforced cement composition, as it may be desired.

For the minute particles used in the current invention, examples should include magnesium hydroxide, calcium silicate powder, mica, calcium carbonate, magnesium carbonate, talc and other inorganic minute particles and burnt chaff powder and other organic minute particles, and those items may be used independently or in combination. The size of minute particles should be 1 to 500□m, and more preferably 3 to 400□m. The mixing quantity of minute particles should be 0.5 to 30 weight parts to the cement of 100 weight parts and more preferably 1 to 20 weight parts. If either of the said ranges is not met, the moldability will be inferior, and if the particle size is too large or the loadings are too much, in particular, the strength will also be lower.

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The perlite used in the current invention should be such perlite that is produced from pearl stone or obsidian calcined and foam-processed, having an independent porous foam-expanded structure in which independent minute air bubbles are concentrated.

Perlite, having a hollow structure in which obsidian or pearl stone has been calcined and foam-processed, has conventionally been used as light-weight aggregate. However, it has a single structure having ping-pong ball-shaped air bubbles, and therefore, it is prone to destruction during the process of kneading, and if it is destroyed, it loses completely the light-weighting effect. In comparison with above, the porous perlite used in the current invention has higher strength due to its independent porous foam-expanded structure, and therefore, it is not prone to destruction when in kneading, and even if it is destroyed, the resulting fragments still contain air bubbles, and the light-weighting effect has not been lost, and the fragments are not shaped so flat as the conventional perlite, it keeps particle shape owing to its independent air bubbles, and therefore, its bearing effect prevents the extrusion moldability from deterioration.

Porous perlite has a mean particle size of 0.2 to 1.2mm, and it should preferably 0.3 to 1.1mm. If said particle size is smaller than 0.2mm, increased extruding pressure will worsen the moldability when in

extrusion, and if it is larger than 1.2mm, increased extruding pressure will worsen the moldability when in extrusion in a similar way, and furthermore the light-weighting efficiency will be lowered when light-weighting is needed.

If porous perlite is used, of which the distribution proportion of particle size of 0.15 to 1.3mm is 70% or higher, and more preferably 80% or higher, the moldability and the processibility will be further enhanced, which is desirable.

The bulk density of porous perlite is 0.15 to $0.3g/cm^3$, and should preferably be 0.17 to $0.25g/cm^3$. If said density is smaller than $0.15g/cm^3$, and the porous perlite becomes more prone to destruction, and the light-weighting efficiency lowers and the moldability becomes worse, and if it is larger than $0.3g/cm^3$, light-weighting cannot be achieved and also the moldability becomes worse.

the mixing quantity of porous perlite should normally be 1 to 120 weight parts to the cement of 100 weight parts, and more preferably be 3 to 100 weight parts.

The loadings of perlite should vary with the setting of the density of molded object. If the lighter weight is to be promoted, addition of 30 weight parts or more will be required. If the quantity of usage is less than 1 weight part, no moldability improvement effect will be achieved, and if it is too much, the moldability will be deteriorated.

First, mix sufficiently, in a dried condition, a fiber-reinforced cement composition of the current invention containing the abovementioned cement, sepiolite and pulp, and minute particles and/or perlite as desired, and add an appropriate amount of water, then knead it, and perform extrusion of the resulting kneaded material under pressure, leave (for curing) the resulting molded object under the prescribed conditions to ensure solidification, and thus producing a cement molded object.

In any of the abovementioned mixing process, kneading process and extrusion process, any general-purpose equipment can be used.

The usage of the abovementioned water depends on the mixing quantity of each of the abovementioned components and the extrusion conditions, and it is not specifically limited, but it should be 30 to 250 weight parts to the cement of 100 weight parts, and preferably be 40 to 200 weight parts, in general.

Besides the previously mentioned components, reinforcing fiber, plasticizer, aggregate and other additives may be mixed properly to cement composition of the current invention, as necessary.

For the reinforcing fibers, examples should include vinylon, polypropylene (PP), polyethylene, acrylic resin, aramid polyester, carbon and other organic fibers and stainless steel fibers and other metallic fibers, rock wool and other inorganic fibers. Those items are effective in the enhancement of shape-retaining property of unhardened cement molded object after extrusion and the bending strength and the impact resistance of the resulting cement molded object, but the use is limited by the heat resistance required in the manufacture process, whether autoclave curing is implemented or not. [Note: The original Japanese text is not complete grammatically.

For plasticizers, examples should include methyl cellulose, hydroxyethylcellulose and others.

Plasticizers have functions to give viscosity to the kneaded material and to enhance the moldability when mixing and extruding each component of composition, and its usage should be 0.5 to 10 weight parts to the cement of 100 weight parts. If the usage is too little or too much, the viscosity of kneaded material becomes inadequate, deteriorating the moldability.

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If the abovementioned reinforcing fiber is to be added, use 0.5 to 10 weight parts to the cement of 100 weight parts in the case of organic fibers, 2 to 20 weight parts in the case of metallic fibers, and 1 to 20 weight parts in the case of inorganic fibers, and if the loadings are too little, the reinforcing effect will be lost, and if it is too much, dispensability will be inferior and the surface smoothness of molded object will be

low.

For aggregate, examples should include sand, crushed sand, blast furnace slag, silica sand, silica stone powder and others. Those items may be used independently or in combination, but in the case of implementing autoclave curing, desired items should be silica sand and silica stone powder, which abound in SiO_2 content, and should contribute to the strength enhancement and dimensional stability of molded object by synthesizing calcium silicate. The size of aggregate particles is 0.01 to 2mm. If the particle size is smaller than the abovementioned range, the moldability will be inferior, and if it is larger than the abovementioned range, the processibility will be worsened. The usage of aggregate should be 50 to 150 weight parts to the cement of 100 weight parts. If the usage is less than the abovementioned range, the reinforcing effect will be lost, and if it is more than the abovementioned range, the strength will be lower.

The above paragraphs have described cement compositions used in the current invention mainly in relation to the method of extrusion, but the compositions may be used also for casting molding, sheet making method and press molding.

Action

The current invention cannot achieve the expected effects until both sepiolite and pulp are simultaneously used. Furthermore, the effects will be much more ensured by the use of minute particles and perlite.

If we are going to extrude cement compositions that do not use asbestos, the problem may often be the very molding process rather than the strength of the resulting molded object. In other words, problematic phenomena would include: occurrence of bad surface smoothness of molded object; increased extruding pressure obstructing the push-out process; and cement composition blocking inside the extruding machine, disabling the detruding process.

For prevention of such phenomena, it is necessary for cement compositions to retain sufficient fluidity even under high pressure in the extruding machine. To ensure the above, important are the complete dispersion of the compositions and the water retaining characteristics to keep added water uniformly in the composition even under high pressure.

Different from asbestos, sepiolite is high in the water retaining characteristics due to its unique hollow structure, and it has an imminent performance as an alternative for asbestos, but by itself, it does not exert sufficient extruding characteristics. On the other hand, pulp also has a large quantity of water retaining characteristics due to its surface hydrophilicity, but it is a little lower in the water retention ability under high pressure, and therefore, water separation (or breathing) from composition takes place when in extrusion, which worsens the extrusion moldability, and sometimes the surface smoothness of molded object is deteriorated due to its difficulty of dispersion.

Either of pulp and sepiolite by itself shows only insufficient performance, however, if they are introduced in combination, sepiolite complements the dispersion of pulp, ensuring sufficient performance of water retaining characteristics under high pressure, for example, and it has been revealed that the extrusion moldability can be drastically enhanced. Pulp, in general, is treated as a fiber-reinforcing material in a cement composition, but the current invention primarily takes the effects on the extrusion moldability.

Perlite, consisting of minute particles, works to help the effects on the moldability enhancement of pulp and sepiolite as mentioned above. Perlite contributes also to light-weighting of molded object, but use of small bit of perlite can enhance the moldability even in the case of not needing light-weighting. Because the moldability is likely to deteriorate in the case of aiming at light-weighting, as a matter of course, the enhancement effect of the moldability of perlite in the current invention will be remarkable.

The following paragraphs describe the current invention in more detail using embodiment cases, where the current invention is never limited to such embodiment cases.

Embodiment Cases 1 to 5, Comparative Cases 1 to 3 and Reference Case

(1) Raw materials other than water are uniformly mixed in an Eirich mixer according to the mixing ratio

(weight parts) shown in Embodiment Cases and Comparative Cases.

(2) Load water, and continue mixing.
(3) Use a kneader to give sufficient kneading.
(4) Load the kneaded material into a vacuum extruding machine, and extrude the material in a cross section of 12 x 250mm.
(5) Steam-cure unhardened extruded material at 80°C for 5 hours.
(6) Autoclave-cure the material at 160°C for 4 hours. Do not apply high density items to autoclave curing, and after steam curing, leave them in the room for 7 days for further curing (Embodiment Cases 4 and 5 and Comparative Case 3).

(7) Materials are cut into the prescribed dimensions.
(8) Materials are completely dried at 105°C for 24 hours.

The pressure of extrusion and the physical properties and processibility of produced cement molded object were measured, and the results are shown in Table 1.

The following methods were used for measurement:
(1) extruding pressure (kg/cm^2): The pressure of the resistance section that runs from the extruder barrel to the mold was measured by a bourdon tube pressure gage mounted immediately before the tapered die.
(2) Specific gravity: measured after leaving for 24 hours of drying.
(3) Bending strength (kg/cm^2): Materials were cut in the direction parallel to the extruding direction into pieces of width of 40mm x length of 160mm, and they were left for 24 hours after drying. Those samples were supported at intervals of 100mm, and a load was applied on the center at the velocity of 0.5mm/min while the measurement was conducted.
(4) Nailing characteristic: measured after leaving for 24 hours of drying. Long items were cut into pieces of 300mm, and a 2.5□ gypsum board nail was driven at the position 30mm from the cut section and 25mm from the product width end face (stainless steel texture screw nail 13 x 45).
@: Nail was driven lightly, and no problem found in the samples.
□: Driving resistance is strong, but no problem found in the samples.
□: A crack emerged on the back of sample.
×: Sample was broken.
(5) Sawing characteristic: Sample was left for 24 hours after drying, and then cut with a slate saw.
@: No problem found in the samples.
□: No problem found in the samples, but cutting resistance is high.
□: A crack emerged.
×: The sample could not be cut because of the strong cutting resistance.
(6) Surface smoothness: Visual observation
□: Smooth surface.
×: Small irregularity remains conspicuous.
(7) Physical properties of light-weight aggregate: performed as per JI S A5007 "Perlite".
i) Particle size distribution: Classification was made using sieves of five or more kinds, which were suitable to each test sample, out of sieves of 0.037mm (400 mesh) to 2.4mm (8 mesh).
•Mean particle size: The particle size (sieve mesh dimension in mm) {found} at 50% {= midst} (weight base) of total frequency (amount of {those that have} passed the sieve mesh (weight %)
•Proportion of particle size of 0.15 to 1.3mm: The difference (remainder) of the cumulative total of frequency values of particle size of 1.3mm less the cumulative total of frequency values of particle size of 0.15mm
ii) Bulk density: The aggregate weight when aggregate is put in the prescribed vessel divided by the volume

Table 1

	Embodiment Cases	Comparative Cases	Reference Case

		1	2	3	4	5	1	2	3	5
Composition	Cement (1)	100	100	100	100	100	100	100	100	100
	Silica stone powder	65	65	60	20	-	65	65	-	65
	Light-weight aggregate (2)	70	60	70	15	-	70	70	-	70
	Asbestos (3)	-	-	-	-	-	-	-	-	15
	Sepiolite (11)	15	15	10	10	8	-	15	10	-
	Pulp (4)	12	8	15	5	3	12	-	-	15
	Vinylon (6)	-	-	-	3	3	-	-	3	-
	PP fiber (5)	3	3	4	-	-	3	3	-	3
	Rockwool (7)	-	-	-	10	-	-	-	10	-
Weight parts	Mg hydroxide (9)	-	-	2	2	-	-	-	-	-
	Chaff powder	-	8	-	-	-	-	-	-	-
	Water reducing admixture (10)	-	-	-	2	-	-	-	-	-
	Plasticizer (8)	3	2	3	2	1	3	3	2	3
	Water	130	120	140	60	40	120	110	50	150
Extruding pressure (12)		9.5	8.5	9.0	7.5	8.0	15.0	Molding impossible	13.5	9.0
Physical properties	Specific gravity	1.08	1.15	1.02	1.45	1.79	1.09	-	Molding impossible but crack emerged	1.06
	Bending strength (12)	135	158	124	218	276	103	-		140
Surface smoothness		□	□	□	□	□	×	-	×	□
Nailing characteristic		@	@	@	-	-	□	-	-	-
Sawing characteristic		@	@	@	-	-	□	-	-	-

{Note: Japanese normally use a circle for "Good", a cross for "Bad", a triangle for "middle" and a double circle for "Excellent".}

(1) Ordinary portland cement
(2) Mean particle size: 0.45mm
Particle size distribution: 88% occupied by those ranging from 0.15 to 1.3mm
Density: 0.196 g/cm^3
Name: pearl stone perlite
Structure: independent porous foam-expanded structure
(3) Chrysotile asbestos – 6D
(4) Hardwood pulp
(5) "Mercury" 3mm by Daiwabo {renewed name of Daiwa Bouseki (= Spinning)}
(6) "RKW 1.82*3" by Kuraray {Renewed name of Kurashiki Rayon}
(7) "PAMCO fiber" by Pacific Metals
(8) "Metolose", methyl cellulose 90S H-3000, by Shin-etsu Chemical
(9) Asahi Glass
(10) "Mighty # 50" by Kao
(11) "GSS" by Gunze
(12) Kg/cm^2

Effects of invention

The fiber-reinforced cement composition of the current invention enables {users of the invention} to manufacture cement molded objects that are low in the extruding pressure during the process of extrusion. superb in the moldability, and excellent in the nailing, sawing and other processibility in the case of surface smoothness, bending strength, and low density items without using harmful asbestos.

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(51) Int.Cl.^{5}	I.D. symbol	Patent Office Control No.
C 04 B 28/02		2102-4G
// (C 04 B 28/02		
14:10		2101-4G
14:18		2101-4G
16:02)		2101-4G

JP4193748AFIBER-REINFORCED CEMENT COMPOSITION

Assignee: ***KURASHIKI BOSEKI KK***
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Application Number: JP1990327779A
Application Date: 1990-11-27

PURPOSE: To obtain a fiber-reinforced cement composition capable of producing a formed article excellent in compression moldability, surface smoothness and workability such as nailing and sawing by incorporating sepiolite and pulp into cement.

CONSTITUTION: (A) One hundred pts.wt. of cement, (B) 1-30 or preferably 3-25 pts.wt. of sepiolite (-type is appropriate, and the fiber diameter is preferably controlled to 0.1-0.5 m and the fiber length to 5 m), (C) 1-40 or preferably 2-30 pts.wt. of pulp (virgin pulp is preferable, and the fiber length is adjusted to 0.05-5 or preferably to 0.1-3mm) and particulate and/or porous perlite having open cells, as required, are mixed to obtain a fiber-reinforced cement composition. From 0.5 to 30 pts.wt. of particulate perlite (having 1-500 m particle diameter) and 1-120 or preferably 3-100 pts.wt. of porous perlite are mixed with 100 pts.wt. of cement.